Standard Operating Procedure for the Determination of Radon in Air

1.0 Location

This procedure is performed in the radiation testing laboratory, room 310.

2.0 Purpose

This method determines the amount of Radon 222 in air in pCi/L.

3.0 Scope

A charcoal detector is exposed indoors for approximately 48 hours. The detector is closed and mailed immediately to this laboratory for radon analysis by liquid scintillation in support of Environmental Health. The detection limit is 0.4 pCi/L, precision is +/- 10% error, and accuracy is +/- 25%.

4.0 References

4.1 Packard 2500 TR Operating Manual

4.2 Instructions for operation of Niton Software - See Niton Software Operating Manual.

4.3 Instructions for operation of liquid scintillation counter - See Packard 2500 TR Operating Manual

5.0 Sample Handling and Preservation

5.1 Minimum detector exposure time: 12 hours

5.2 Maximum detector exposure time: 96 hours

5.3 Recommended detector exposure time: 48 hours

5.4 Minimum elution time: 8 hours

5.5 Maximum time from end of exposure to test: 192 hours (8 days)

6.0 Apparatus and Materials

6.1 Packard Liquid Scintillation Counter 2500 TR

6.2 Packard radon in air detectors (Niton)

6.3 10 mL dispenser

6.4 Instafluor liquid scintillation cocktail (Packard)

6.5 Quality Control Samples

7.0 Procedures

7.1 Calibration

A cassette labeled SNC/IPA and containing unquenched C-14, H-3, and background vials is placed in the liquid scintillation counter flagged once per week. This normalizes the photomultiplier tubes. A background is counted. Efficiencies, figure of merit, and chi squares are calculated. Once per month these values are printed out for hard copy storage. These values must meet the specifications listed in Chapter 1 of the Packard operating manual or the instrument manufacturer is contacted.

7.2 Analysis

7.2.1 Set time (clock is slow).

7.2.2 Uncap an unopened radon detector, add 10 mL of Instafluor. Let stand for 7-8 hours and count for 100 minutes. Subtract this as a background count from all sample counts via count conditions in the Edit Protocol program of Radon in Air (protocol #3).

7.2.3 Samples are received in the log in area and log numbers are assigned.

7.2.4 A worklist is printed the day the samples are received.

7.2.5 The sample detectors are placed in a liquid scintillation cassette in log number order.

7.2.6 10 mL of Instafluor is dispensed into each detector, down the side (do not mix). The start time is noted for each cassette.

7.2.7 A cassette with an empty liquid scintillation vial (Protocol # 10 - dummy) is placed in the counter in front of the cassettes with samples to be counted (Protocol # 3 - radon in air).

7.2.8 An 8 hour delay in counting is needed for elution of the radon from the charcoal in the detector (this is achieved by counting the liquid scintillation vial in the dummy protocol for an 8 hour count time).

7.2.9 Press the start button to start the liquid scintillation counter.

7.2.10 Press F5 (DOS exit) to exit Packard software.

7.2.11 Type cd\radon

7.2.12 Type start manual

7.2.13 Type in your 3 user initials

7.2.14 Choose new order entry

7.2.15 Type in ND for last name/company

7.2.16 Page down to vial number - enter the log # (Example: If log number is 92-E412, enter 412).

7.2.17 Enter air or water for test

7.2.18 Enter month, day, and military time for expose start/end.

7.2.19 Enter cassette number position in cassette

7.2.20 Upon completion of the 12 cassette positions available, press F10 to fill the order.

7.2.21 Choose Elution from menu - Enter cassette number and elution time.

7.2.22 Type exit to return to Packard software.

7.2.23 Enter results into LIMS via worklist

7.2.24 Step by step instructions for operating the Packard liquid scintillation

counter are found in Packard's Operating Manual and instructions for using the radon software are found in the Niton software operating manual.

8.0 Quality Assurance/Quality Control

8.1 Blanks

Unexposed detectors are filled with 10 mL of Instafluor and counted after an 8 hour delay run 25/month or 5%.

8.2 Replicates

Replicates are sent in from participants at the discretion of the Environmental Health Section 50/month or 10% Duplicates must have error of 10% or less.

8.3 Quality Control Samples

Niton sends 4 spikes/month. We are compared to the true value + alternate spike QA to other QA participants. Detectors are sent to EPA in Montgomery, Alabama and exposed in their radon chamber. 90 % are accuracy samples half of which are 5 pCi/L and half of which are 10 pCi/L. Acceptable accuracy is +/- 25% and acceptable replication is +/- 10%. The instrument manufacturer is called if these limits are not met.

9.0 Data Analysis

9.1 The raw counts per minute are converted to pCi/L by the Niton software:

$$c(pCi/L) = (N-NBkg) \times 100/(5 \times 2.22 \times .964)$$

where: c = result for sample in pCi/L
N = counts per minute for sample
NBkg = counts per minute for Background
5 = 3 alphas + 2 betas
2.22 = number of decays of radon per minute corresponding to 1 pCi/L
.964 = correction for radon in air and not Instafluor

9.2 The calculated results are entered into the LIMS via worklist, reports for actual samples are printed and copies are sent to Environmnetal Health and copies are

retained in the lab files. Quality control samples are identified as class Q, results are calculated and entered into the LIMS and the printed reports are signed by the Director of Chemistry and are filed in the laboratory.

10.0 Documentation

10.1 When the detectors are received they are assigned log numbers and are logged into the LIMS. Generated bench sheets are given to the analyst

10.2 The analyst creates a worklist to use for entering necessary data into the Niton software on the liquid scintillation counter and to record calculated results for entry into the LIMS.

10.3 Final calculated results are entered on the bench sheets which are used for validating results on the printed reports.

11.0 Records

11.1 Completed worklists, bench sheets, a copy of the summary of counts per minute results from the Niton software, and a copy of the report are filed at the chemistry laboratory.

11.2 Report copies are also sent to the Environmental Health Section.